INTERPETROL BERMUDA LTD.

v.

THE OWNERS OF & ALL OTHER PERSONS INTERESTED IN THE SHIP "NORSEMAN"

HIGH COURT MALAYA, JOHOR BAHRU
LC VOHRAH J
[ADMIRALTY IN REM NO. 1 OF 1982]
7 AUGUST 1992

SHIPPING: *Contamination of plaintiffs' fuel oil cargo - Source of contamination - Plaintiffs had hired tanker Norseman to carry the fuel oil cargo from Bahrain - Norseman unable to berth to load cargo as it was too large a tanker - Tanker Kodiak employed to tranship fuel oil cargo into Norseman from four shore tanks in Bahrain - Plaintiffs alleged contamination occurred by crude oil that Norseman was already carrying before transhipment of fuel oil - Damages sought in respect of losses sustained by plaintiffs - Defendants denied liability - Claimed alleged contamination did not occur in their custody - Plaintiff had to establish that contamination occurred to fuel oil whilst it was on the Norseman on a balance of probabilities - Plaintiffs also had to establish that they suffered losses due to the contamination.*

The plaintiffs as owners of a cargo of 73,029.72 metric tons of B-962 fuel oil sued the owners of the tanker *Norseman* for damages alleging that the fuel oil cargo which the tanker had been hired to carry was contaminated while on board by the crude oil that it was carrying.

On 31 January 1981, the *Norseman* anchored off Bahrain laden with two parcels of crude oil (Arabian Light and Mubarek Heavy) which had been loaded at the ports of Ras Tanura and Mubarek respectively. On 5 February 1981, it received orders for the loading of the said fuel oil cargo from the tanker *Kodiak* which had been employed to tranship the cargo from four shore tanks in Bahrain into *Norseman* as the latter was too large a tanker to berth at the loading berth. On 8 February 1982, the transhipment was completed.

The plaintiffs alleged that the contamination caused the degradation of the flashpoint of the fuel oil cargo and that such degradation prevented the resale of the fuel oil cargo immediately thereby suffering losses.

It was argued by the parties that:

1. On the event the fuel oil was contaminated on board the *Norseman* then it was for the defendants to show it occurred without their fault.
2. If the plaintiffs by direct or indirect evidence proved that the fuel oil cargo was in good condition when it was transhipped into the *Norseman* then the defendants would be liable in negligence for the damage caused by the contamination.

It was also agreed between the parties that once it had been established that the fuel cargo was contaminated in the defendants' custody it was for the plaintiffs to establish that they had suffered losses which was proximately or effectively caused by such contamination.

Held:

[1] The plaintiffs failed to prove that any significant part of the fuel oil was contaminated on the *Norseman* to the extent that it was below specification or that if a significant part was contaminated to that extent such contamination occurred after transhipment into the *Norseman*.

[2] As the plaintiffs had failed to make good their case against the defendants, the suit was dismissed with costs.

[Plaintiffs' suit for damages dismissed with costs.]

For the plaintiffs - Christopher Clarke QC (Cecil Abraham/R.S. Nathan with him); M/s. Shearn Delamore & Co.
For the defendants - Anthony D. Colman QC (K. Anantham with him); Skrine & Co.

JUDGMENT

LC Vohrah J:

This was a suit brought by the plaintiffs as the owners of a cargo of 73,029.72 metric tons of B-962 fuel oil against the owners of the tanker *Norseman* for damages in respect of contamination of the fuel oil cargo which had been transhipped into it from the tanker *Kodiak.*

The relevant facts have been concisely set out in the joint report of the plaintiffs' marine consultants and the defendants' bundle of reports and statements (D2). To recapitulate very briefly, on 31 January 1981 at 1945 hours local time the *Norseman* arrived and anchored off Bahrain laden with two parcels of crude oil, Arabian Light and Mubarek Heavy, which had been loaded at the ports of Ras Tanura and Mubarek respectively and were contained in the tanker's port and starboard wing tanks. On 5 February it received orders for the loading of the fuel oil cargo from the *Kodiak* which had been specifically employed to convey the fuel oil cargo from four shore tanks in Bahrain into the *Norseman* as the *Norseman* was too large a tanker to take up a position at the loading berth. On 8 February the *Kodiak* berthed alongside the *Norseman's* portside at 0910 hours local time. The fuel oil cargo was to be loaded into the *Norseman's* tanks No. 1, 2, 4 and 5 centre tanks. The actual transfer of the fuel oil cargo took place between 1040 hours on 8 February and 0345 hours on 10 February. Chemical analysis performed on the fuel oil cargo subsequently showed that the flashpoint of the fuel oil cargo was off the B-962 fuel oil specification of 150 degrees Fahrenheit (65.6 degrees Centigrade) and the plaintiffs alleged that the fuel oil cargo was contaminated on the *Norseman* by the crude oil that it was carrying.

As to liability, it was common ground that if the fuel oil was contaminated whilst it was on board the *Norseman* it was for the defendants to prove that such contamination happened without their fault. It was conceded by the defendants that if the plaintiffs by direct or indirect evidence discharged their burden of proof that the fuel oil cargo was in good condition when it was transhipped into the *Norseman* then the defendants would be liable in negligence for the damage caused by the contamination. It was therefore for the plaintiffs to establish on a balance of probabilities that damage was caused to the fuel oil cargo whilst it was on the *Norseman.*

As to damages, it was also common ground that once it had been established that the fuel oil cargo was contaminated in the defendants' custody, it was for the plaintiffs to establish that they had suffered loss which was proximately or effectively caused by such contamination.

The essence of the plaintiffs' claim was that the contamination occurring on board the *Norseman* caused degradation of the flashpoint of the fuel oil cargo and that such degradation prevented the resale of the fuel oil cargo until after the light ends had escaped and the flashpoint had been restored to specification by which time the market price of the cargo had fallen. The plaintiffs' case was that the results of the composite sample of the fuel oil

cargo taken from the *Norseman* off Bahrain on 10 February 1981 immediately after transhipment from the *Kodiak* had the consequence that the plaintiffs were only able to resell the cargo on 15 May 1981 and not in February when they would otherwise have done so.

The plaintiffs were represented by Mr. Christopher Clarke QC assisted originally by Mr. Cecil Abraham and later by Mr. R.S. Nathan and the defendants by Mr. Anthony Colman QC assisted by Mr. K. Anantham.

All in all 8 witnesses were called to give evidence, four for each side. The trial extended over four sessions starting on 5 January 1988 and ending on 5 November 1989 and final written submissions including written "interventions" were considered to be closed on 7 March 1991. The documentary evidence before the Court was therefore voluminous and because of the nature of the claim was highly technical. In this regard I would like to express my appreciation to both Mr. Clarke and Mr. Colman for the very detailed manner in which they led the technical evidence in order to make it comprehensible to the Court. The four witnesses called by the plaintiffs were:

1. Mr. Nils Olov Ytterland who at the material time was a laboratory technician employed by Petroleum Inspectors, E.W. Saybolt & Co. SA;
2. Mr. Henri A. Lehner, the general manager of the plaintiffs at the material time;
3. Captain Gerald Keith Waite, a marine surveyor employed by T.J. Gunners & Sons Ltd., Marine Surveyors and Consultants specialising in hydrocarbon analyses;
4. Mr. Alan Benjamin Smaridge, a chemist surveyor employed also by T.J. Gunners & Sons Ltd.

On behalf of the defendants the following four persons were called:

1. Chief Officer Odd Gjernes, the holder of a master's certificate, who was the Chief Officer of the *Norseman* at the material time;
2. Mr. Constantine Andreou, a chemist who was a partner of Andreou Chemical Laboratories specialising in petroleum and metal analyses;
3. Mr. David Andrew Hughes, a solicitor acting for the defendants; and
4. Captain David Ashley Pockett, a Master Mariner with wide consultancy experience in investigations relating to cargo contamination and oil shortages on oil tankers.

In addition to the evidence of the above 4 witnesses the defendants placed great reliance on the affidavit evidence deposed to on 5 January 1988 by Torstein Granheim, the pumpman of the *Norseman* at the material time, who was unable to attend the trial because his employers at the time of the trial were unwilling to release him from his pressing duties.

All the witnesses who gave evidence including Granheim were in the nature of expert witnesses whose veracity was in no way questioned. As to their understanding of the English language, I found that two defence witnesses, namely Gjernes and Andreou, had on several occasions difficulty in comprehending and answering questions put to them by Mr. Clarke in cross-examination when they kept agreeing to his suggestions when obviously had they understood their import they would not have done so.

After considering the totality of the evidence presented including the documentary exhibits and the very comprehensive written submissions and "interventions" of learned Counsel, I found that the plaintiffs had failed to make good their case against the defendants and I

accordingly dismissed their suit with costs. I accepted the arguments put forward on behalf of the defendants.

Now to the evidence.

In order to prove liability the plaintiffs had to establish that the flashpoint was within specification when the cargo entered the *Norseman* and that the contamination which occurred on board caused the flashpoint to be degraded below specification.

Proof that the fuel oil cargo was in a contaminated condition at Bahrain: Direct Evidence

The evidence relied upon by the plaintiffs as showing that there had been contamination of the fuel oil cargo to any extent was confined to the analyses of samples taken by Granheim under the supervision of Saybolt who had been appointed surveyors at Bahrain on behalf of the plaintiffs. I had no reason to reject the affidavit evidence of Granheim referred to indicating that the samples were taken about two hours after completion of transhipment and that they were taken only from the mid levels of each of the No. 2, 4 and 5 centre tanks and from about 2 to 3 metres below the surface of the fuel oil cargo in No. 1 centre tank which was slack with a cargo sounding of 55 ft.

It was the evidence of Ytterland that samples were taken both from the mid-level and the top of No. 2, 4 and 5 centre tanks and only one sample from No. 1 centre tank. Two composite samples were made up by taking and mixing equal quantities from the samples of each tank. Each composite sample was placed in a 3.8 liter container, one being left on board the *Norseman* (see P2/F12) and one being taken ashore by Ytterland at Bahrain and left with Core Laboratories for analysis.

The composite sample left with Core was in due course analysed and the results were telexed by Core to Saybolt's Cyprus office, where Ytterland was based, on 14 February 1981. The analysis showed a flashpoint of 100 degrees Fahrenheit, a density at 60 degrees Fahrenheit of 0.9555 and a kinematic viscosity at 50 degrees Centigrade c/s of 120 equivalent to 970 secs. (Redwood No. 1). Saybolt passed the flashpoint analysis to the plaintiffs by telex on 18 February 1981.

The composite sample left on board the *Norseman* was analysed by Andreou in May 1981, after the vessel arrived at Aghii Theodori, and the results obtained were not far out from those obtained by Core, namely flashpoint 44 degrees Centigrade (that is 111 degrees Fahrenheit), specific gravity at 60 degrees of 0.9516 and viscosity (Redwood No. 1) 870 secs. (P2/G22).

It was common ground that the composite samples taken by Saybolt at Bahrain could not have been representative of the whole fuel oil cargo in the sense that they were not derived from a homogenous source. Two plausible reasons were furnished by the defence for their unrepresentative character:

(a) If a comparison was made between the specific gravity of the post-transhipment Bahrain sample (0.9555 or 0.9516) and that of the *Kodiak* after loading sample (0.9710) - P2/E9 - and it was assumed that the explanation for the change lay in admixture with the fuel oil of a lighter substance such as crude oil, the amount of Arabian Light of specific gravity 0.8596 (P2/G23-24) or Mubarek Crude of specific gravity 0.8336 (P2/G24) needed to reduce by contamination the specific gravity of the whole cargo of fuel oil to that extent would be 10,800 tons of Arabian Light and 8,280 tons of Mubarek crude. These quantities were far in excess of any amount of crude oil which could have emanated

either from the *Norseman* having regard to the apparent deficiencies in crude oil which were alleged subsequently to have been found, namely a maximum of 1005 Long Tons ("LT") Arabian Light (P10/6A) and 236 L.T. Mubarek (P10/6) as calculated by Waite, or from the *Kodiak*. Smaridge agreed in cross-examination that, whereas the composite samples would have had to contain substantial percentages of crude oil to give those specific gravities found on analysis, the whole cargo could not have contained such high percentages of crude.

(b) The composite samples were not made up on a volumetric basis but by taking equal parts from each of the four tanks on the *Norseman*. From P2/F10 it was clear that a true volumetric sample would have contained the following proportions:

No. 1 centre	:	19.1% (92,256 barrels)
No. 2 centre	:	26.72% (129, 100 barrels)
No. 3 centre	:	27.3% (131,918 barrels)
No. 4 centre	:	26.87% (129,795 barrels).

In consequence of the unrepresentative nature of the Bahrain post-transhipment samples and of the fact that they were composite samples, I agreed with the defendants that it was impossible to say:

(a) whether the flashpoint of the whole cargo on the *Norseman*, if it were mixed in one container, would be above or below specification of 150 degrees Fahrenheit (65.6 degrees Centigrade);

(b) whether the contamination and the consequent low flashpoint was confined to one tank or occurred in more than one tank on the *Norseman*;

(c) whether in respect of any tank where there was contamination, such contamination was uniformly spread throughout the tank.

Accordingly, I agreed with the defendants that the only conclusion that could be drawn from the evidence relating to the samples was that, having been taken and mixed in the manner described by Granheim and Ytterland, (i) the true analysis of the composites was that which was found and (ii) if the contaminant was crude oil of the kinds carried on the *Norseman*, the composite sample analysed by Andreou (No. 6) would have had to include 17.5 percent Arabian Light crude by volume or 14 percent Mubarek crude by volume.

The samples taken at Bahrain on the *Kodiak* before and on the *Norseman* after transhipment were the only evidence put forward in support of the proposition that the cargo was in a contaminated condition after transhipment. As was pointed out, if one ignored the evidence of those samples it could not be inferred from the ullage measurements of the *Norseman's* fuel oil and crude oil cargo that there was any contamination of the fuel oil before the vessel sailed from Bahrain because the apparent increase in the volume of fuel oil in some of the centre tanks and in the aggregate fuel oil cargo volume were increases which, if they took place at all, could only have taken place after the taking at Bahrain of the post-transhipment samples. As appeared from the affidavit evidence of Granheim, each centre tanks was ullage-measured at the same time as it was sampled and the whole operation took place about two hours after completion of transhipment. The fuel oil volume increases identified in Waite's second calculation P16 were increases over the volumes recorded on that occasion. There was no evidence from which it could be inferred that there was any volume increase in the fuel oil before ullages were taken at Bahrain. In the absence of any such evidence there was

nothing apart from the samples from which it could be inferred that the fuel oil cargo was to any extent in a contaminated condition after transhipment and nothing at all from which it could be inferred that it was more contaminated after transhipment than it had been before transhipment.

It was clear that the fuel oil cargo was in a contaminated condition after transhipment at Bahrain but it could not be said what the overall flashpoint of the whole cargo when mixed was and it could not be said whether the whole or part of the cargo was contaminated or the extent (in terms of flashpoint to which the contaminated parts of the cargo were contaminated and in particular whether the flashpoint of the whole cargo in any given tank on the *Norseman*, if mixed, was above or below B-962 fuel oil specification of 150 degrees Fahrenheit.

There was therefore direct evidence by way of the samples that immediately after it had been transhipped the fuel oil cargo collected from the *Norseman* on 9 February 1981 contained a contaminant which must have had a flashpoint below that recorded in the Bahrain composite samples taken by Ytterland notably 100 degrees Fahrenheit but there was no direct evidence of:

(a) whether the flashpoint of the cargo as a whole when mixed in one tank was contaminated to the extent that it was off specification (150 degrees Fahrenheit);

(b) whether the contents of any given tank when mixed, that is taken from all levels, were contaminated to the extent of being off specification.

Proof of the condition of the fuel oil before transhipment on to the Norseman: Direct Evidence

It was common ground that some contamination of the fuel oil took place between the time when it was pumped into the *Kodiak* on 7 February 1981 and the time when it was sampled on 9 February 1981 immediately before transhipment.

The evidence as pointed out by the defendants was as follows:

(a) The flashpoint of the composite sample taken by *Banoco* after completion of loading the *Kodiak* at Bahrain was 120 degrees Centigrade (248 degrees Fahrenheit) and the specific gravity was 0.9710.

(b) By the time that the pre-transhipment composite sample was taken by Ytterland for Saybolt on 9 February 1981 something had caused the flashpoint of that sample to be 150 degrees Fahrenheit, a reduction of 98 degrees Fahrenheit, on that of 7 February *Banoco* sample.

(c) In order for the Saybolt 9 February preshipment composite sample to have a flashpoint as low as 150 degrees Fahrenheit some substances must have entered the fuel oil on the *Kodiak* and that contaminant must have had a flashpoint below 150 degrees Fahrenheit.

(d) The plaintiffs' expert's report at P4/5 initially prepared by Waite and Smaridge conceded that:

> The discrepancy in these figures may be accounted for, in part, by differential sampling and/or laboratory analysis procedures although it is considered doubtful that under normal circumstances these factors could explain the discrepancy in full. It is therefore evident that a degree of contamination may have taken place on board the *Kodiak...;*

(e) In the course of his evidence Waite revised this part of his report but he accepted in cross-examination that "there must have been contamination of the fuel oil cargo while on board the *Kodiak*".

(f) In the course of his evidence during cross-examination Smaridge also agreed that some contamination must have taken place on the *Kodiak*.

I accepted the argument of the defendants that, assuming there must have been some contamination of the fuel oil while on the *Kodiak*, the evidence as to the extent to which the cargo was then contaminated was unclear. It was confined to the Saybolt pre-transhipment sample. The analysis by Core at P2/G2 showed a flashpoint of 150 degrees Fahrenheit but no other details of, for example, specific gravity or viscosity. According to the evidence of Ytterland this composite sample was made up of equal parts by volume from each of the *Kodiak's* nine tanks. The nine tanks contained cargo volumes which represented widely varying proportions of the total volume as seen from the volumes recorded in the Cargo Tank Volume Report at P2/F15. Whereas each tank contributed one ninth (11.11%) to the composite sample, No. 1 port and starboard wing tanks each contained a volume of fuel oil equivalent to about 3.9% of the whole. Similarly although each tank contributed 11.11% to the composite sample, No. 4 port and starboard each contained about 8.6% of the whole. Whereas those wing tanks were therefore over-represented in the composite sample, the No. 1, 2 and 4 centre tanks were under-represented in as much as No. 1 centre contained 19.1 percent of the whole cargo, No. 2 centre contained 21.8 percent and No. 4 centre 13 percent, whereas each of them only contributed 11.11% to the composite sample. By reason of the failure to take a volumetric sample, that is a composite sample made up of contributions from each tank in proportion to their part of the cargo as a whole it was impossible to say whether the bulk of the cargo had the same flashpoint or a lower or higher flashpoint than that of the Saybolt sample (150 degrees Fahrenheit) as was accepted by Waite.

It was equally impossible to ascertain from the sample at P2/G2 how the contaminant was distributed in the *Kodiak's* tanks, whether in some tanks the bulk had a flashpoint below 150 degrees Fahrenheit and in others above 150 degrees Fahrenheit.

The condition of the fuel oil cargo on the *Kodiak* immediately before transhipment evidenced by the samples taken by Saybolt could therefore, I agreed with the defendants, be summarised as follows:

(a) there was some quantity of contaminant already in the cargo;

(b) the contaminant had a flashpoint below 150 degrees Fahrenheit;

(c) it was impossible to say:

(i) in relation to any given tank on the *Kodiak* whether the flashpoint of the contents when mixed was above or below or exactly 150 degrees Fahrenheit;

(ii) in relation to the total cargo in all the tanks if mixed into one tank the flashpoint was above or below exactly 150 degrees Fahrenheit.

There was therefore no direct evidence that immediately prior to transhipment the fuel oil cargo as a whole or the contents of any particular tank were up to specification, that is, had a flashpoint of 150 degrees Fahrenheit or above. There was direct evidence that at some stage between 7 and 9 February 1981, while the fuel oil was on the *Kodiak*, some contaminant having a flashpoint below 150 degrees Fahrenheit entered the cargo and reduced the flashpoint of the whole or part of the fuel oil.

In the circumstances, I was of the view that the plaintiffs had not proved by direct evidence on the balance of probabilities that the fuel oil while in the defendants' custody was damaged by a contaminant which reduced its flashpoint from at or above 150 degrees Fahrenheit to below 150 degrees Fahrenheit.

The plaintiffs therefore had to prove by indirect evidence that:

(i) although the fuel oil had to some extent been contaminated on the *Kodiak* it had not been contaminated to such an extent that the cargo as a whole or the contents as a whole of any of the *Kodiak* tanks had a flashpoint below 150 degrees Fahrenheit; and

(ii) after transhipment to the *Norseman* the fuel oil was yet further contaminated and that the further contamination caused the flashpoint of either the cargo as a whole or at the very least of particular tanks to be reduced from 150 degrees Fahrenheit or above to below 150 degrees Fahrenheit.

Indirect Evidence of the Condition of the Fuel Oil when it left the Kodiak (excluding Chemists' Evidence)

It was submitted by the defendants that the indirect evidence relating to the *Kodiak*, far from establishing that such contamination as had occurred had reduced the flashpoint of any material part of the fuel oil to no lower than 150 degrees Fahrenheit, did in truth point strongly to the inference that the flashpoint was below 150 degrees Fahrenheit. At its very lowest such evidence suggested that the probabilities were equal, that is, that it could not be said to be more probable that the flashpoint was at or above 150 degrees than that it was at lowest temperature. The reasons put forward by the defendants with which I agreed were as follows:

(1) The fuel oil was loaded into unwashed tanks on top of "uncleaned, unpumpable Crude Residues" (P2/El) and probably also a good deal of crude clingage in the upper levels of the tanks. Both Waite and Pockett would not have loaded fuel oil without first washing out the lines and tanks. It was highly significant that the shippers demanded a waiver before agreeing to load the fuel and that the plaintiffs made no objection to providing such a waiver. Lehner's evidence strongly suggested that the plaintiffs had originally intended that the tanks should be properly cleaned but did not do this, probably to avoid delaying the *Norseman*, which was then at anchor off Bahrain, and thereby potentially incurring liability for demurrage under the *Norseman* charterparty. Until this case Pockett had never heard of fuel oil being deliberately pumped into unwashed tanks previously used for carrying crude. Obviously, this was asking for trouble, having regard particularly to the fact that the flashpoint of fuel oil which is part of its specification is so easily depressed by an admixture of crude oil.

At this point, I must say in passing that it was submitted by the plaintiffs that the *Banoco* inspector had not advised that the tanks should be cleaned but I formed the view that the plaintiffs were only too keen on any excuse to have the *Kodiak* loaded despite the telex P1/36/37 advising "utmost caution before loading" and the note of protest P2/E1/1 from the Master of the *Kodiak* to the effect that the vessels' tanks had not been cleaned after the last discharge of crude oil. I found it hard to accept the suggestion put forward by the plaintiffs that the waiver was given only to carry out the first-in sampling. I think this was belied by the telex P1/24A from the plaintiffs authorising loading on board the *Kodiak* "despite inspectors" opinion that tanks are not suitable" and waiving of "specification requirements under our contract."

(2) The plaintiffs' evidence was that they arranged for *Banoco* to take first-in samples from the *Kodiak* tanks. The purpose apparently was to see whether the flashpoint was affected. But the surveyors who took the first-in samples were never called to give evidence as to how these samples were taken and analysed. Further there were other unexplained features of these samples. Firstly, they were composite samples and not separate from each tank, so that if there was contamination in one tank it might not be apparent in the composite sample and there would be no way of identifying the location of such contamination. Secondly, they were samples which by definition would not reflect the effect on flashpoint of clingage at heights greater than 3 feet in the tanks according to pockett. The evidence as to the first-in samples was not of sufficient weight in establishing that the *Kodiak* tanks were clean enough to receive the fuel oil. If a substantial quantity of crude residues and/ or clingage got into the fuel oil, the flashpoint would be adversely affected.

(3) The *Kodiak's* dry certificate (P2/E3) and the time and loading report (P2/E4) suggested that on 6 February 1981 the crude residues were stripped out of the tanks into No. 4 centre whence the "slops" were transferred to No. 3 centre as a temporary and not a dedicated slop tank. The operation of pumping from No. 4 centre to No. 3 centre lasted 1 hour 45 minutes (0100 to 0245 on 6 February 1981). This period according to Pockett could not have included the accumulation of residues from all tanks into No. 4 centre contrary to Waite's view. In view of the fact that the pump capacity was 200 cu.m. per hour, a "significant quantity" would have been transferred to No. 3 centre over a period of 1 hour 45 minutes according to Pockett. After completion of transhipment of the fuel oil to the *Norseman*, Ytterland took dips in the *Kodiak* tanks. The results were recorded on P2/F16 and converted into cargo quantities. Ytterland dipped No. 3 centre tank and found it empty. But if it was then found empty, the question arose as to what had happened to the residues and slops previously pumped into No. 3 centre. They must have gone either into other cargo tanks and become mixed with the fuel oil cargo before transhipment or pumped straight into the *Norseman* according to pockett. Ytterland's ullages at P2/F14 indicated that prior to transhipment No. 3 centre tank was already empty. If the contents of No. 3 centre had been transferred into other tanks containing fuel oil prior to the sampling by Saybolt on 9 February, that would be one explanation for the reduction in flashpoint evidenced by the transhipment sample. Another explanation could be that the other tanks had not been effectively stripped into No. 4 centre and that in some or all of them the "uncleaned umpumpable residues" referred to in the master's notice of protest (P2/E1) left their mark on the fuel oil.

This and other parts of the evidence relating to the *Kodiak* might well have had more light shed on them if the plaintiffs had called the Master and/or Chief Officer and/or pumpman of the *Kodiak* but this was not done, surely a wholly exceptional course for a claimant for cargo damage to endeavour to establish the good quality of a cargo prior to delivery by indirect evidence without calling a single witness from the predelivery carriers and without tendering any explanation for the failure to do so.

(4) Both experts calculated an unaccounted-for balance of deadweight on board the *Kodiak* when it departed from Bahrain for the purpose of doing its transhipment into the *Norseman*. The calculations were shown on p. 18. Pockett had calculated at D8A that the unaccounted for deadweight balance was 3133 m.t. and Waite calculated 2900 m.t. It was Pockett's evidence that this balance must have included both slops and residues and ballast and he accepted that it could not have consisted exclusively of slops. But

he was unable to say how much ballast was included or what the proportion of slops and residues was. If one assumed that Smaridge was correct in estimating that it would be possible to cause the flashpoint of the whole cargo to drop below specification by the admixture of no more than 0.5% of crude, there was nothing in the *Kodiak* deadweight calculations to preclude the secretion on board of 0.5% that is 360 m.t. of crude oil in the form of slops or residues. There was no evidence as to what quantity of what material was in the No. 3 centre tank before the *Kodiak* transferred her crude strippings from No. 4 centre to No. 3 centre. If there was slops and/or other crude already in that tank, a substantial proportion of the total balance of unaccounted for deadweight (2900 m.t. - 3133 m.t.) could have consisted of crude oil in the form of slops or strippings.

(5) It was common ground that the *Kodiak's* previous cargoes had all been crude oil. When it came to preparing the vessel for her fuel oil cargo it would therefore be essential for her lines to be drained of crude and flushed. Not only had the plaintiffs failed to establish that the lines were flushed, there was no proof that the lines were drained of crude. Indeed it seemed to have come as a surprise to the master of the *Kodiak* that he was to load fuel oil as he had received no instructions to clean the tanks prompting him to issue the note of protest at P2 E1/2.

(6) There was strong evidence to suggest that within a period of 24 hours between the time when the *Kodiak* completed loading from the shore tanks at Bahrain and the time immediately prior to the start of transhipment of the fuel oil there was significant changes in the volume of fuel oil recorded in three of the nine tanks. These changes were diagrammatically illustrated in Exhibit D24 (b) produced by Pockett. Both No. 1 port and No. 1 starboard tanks showed substantial increases (5.31% and 4.53% respectively) and No. 4 centre tank also showed a significant increase (2.19%). The overall net increase in cargo volume was 1409 barrels, equivalent to about 213 LT (about 216 m.t.). Having regard to the fact that the cargo temperature between the completion of loading at Bahrain and the time immediately before transhipment had decreased from 117 degrees Fahrenheit to 109 degrees Fahrenheit one would have expected, according to Pockett, a reduction in cargo volume, not an increase. Furthermore the ullages taken at the anchorage should not have been rendered inaccurate by the sea conditions. The conclusion was that something must have got into the fuel oil before the pre-transhipment ullages were taken if there was no measurement error.

The plaintiffs had not called evidence from those on board the *Kodiak* to explain the increase in cargo volume over such a short period of time. It was not suggested that there would be any reason to trim the vessel by the head for any purpose or otherwise to alter the, trim. Nor was any explanation advanced for the overall cargo volume increase. Nor had the plaintiffs adduced any evidence as to the sound condition of the *Kodiak* valves or of their operation by those on board. Yet in the course of discharge of the fuel oil there could be no more than one valve segregating the contents of No. 3 centre from the fuel oil being discharged through No. 2 line. No witness had been called to speak to the effectiveness and condition of the *Kodiak* valves or the proper operation of those valves to maintain segregation.

I therefore accepted the submission of the defendants that there was evidence which strongly suggested that a substantial quantity of crude oil originally accumulated in No. 3 centre tank was unaccounted for and found its way into the fuel oil at some time before Ytterland took the pre-transhipment samples on 9 February. I agreed with the defendants that the increase in cargo volume of the fuel oil was consistent with this.

Indirect evidence of contamination of the fuel oil after it entered the Norseman (excluding chemists' evidence).

The evidence relied upon by the plaintiffs in support of the contention that it was to be inferred that contamination occurred on board the *Norseman* was the apparent increase in the volume of fuel oil after loading from the *Kodiak* and the apparent decrease in the volume of crude oil. The comparative figures set out in Exhibit P/16 showed that as regards the Arabian Light crude cargo loaded at Ju'Aymah there was apparent volume changes on the voyage to Mubarek and further volume changes between Mubarek and Aghii Theodori. There was an apparent continuing reduction in cargo volume in the No. 5 wing tanks and a less pronounced gain in the others. There was an apparent overall loss of 787.59 barrels (0.13 %) in the cargo loaded at Ju'Ayinah and of 1820.77 barrels (0.47%) in the cargo loaded at Mubarek. The latter part of the cargo suffered the main losses in No. 2 Port B and in No. 4 starboard B (370 barrels and 384 barrels respectively). In contrast there were apparent gains in the quantity of fuel oil, there being a substantial gain in No. 1 centre and a further substantial gain in No. 2 centre. There was a substantial loss in No. 5 centre. There was an overall net gain of 4046.38 (0.85%) barrels. The plaintiffs argued that it was to be inferred that the "lost" crude went into the fuel oil cargo and thereby caused the flashpoint to drop.

I agreed with the defendants that the weakness of this argument was that it was chronologically flawed. According to Ytterland, the ullage measurements of the *Norseman's* fuel oil cargo at Bahrain were taken from each tank at the same time as the sample was drawn from that tank. The samples then being mixed to form composite samples, it was these composite samples which were found on analysis to have flashpoints of 100 degrees Fahrenheit (Core) and 111 degrees Fahrenheit (Sample No. 6 - Andreou). Accordingly, by the time when those samples were taken, the contaminant must have already been present in the fuel oil in sufficient quantities to reduce the flashpoint to below specification. Consequently the apparent increase in cargo volume in one of the nos. 1, 2, 4 and 5 centre tanks recorded by comparison of the ullages taken by Saybolt at Bahrain with those subsequently taken at sea on 8 April 1981 and those taken at Aghii Theodori was not evidence from which it could be inferred that any or any sufficient amount of crude from the *Norseman* was already present in the fuel oil at the time when the Bahrain ullages were taken.

I agreed with the defendants that if the position were that at the time of transhipment there was an open and running leak of crude oil into the fuel oil tanks which having already started, (a) had the effect of reducing the flashpoint of any significant part of the cargo below specification and (b) continued after the Bahrain ullages were taken whereby the apparent gain in the volume of fuel oil after Bahrain (P/16) was to be explained, the flashpoint of the fuel oil would have continued to be degraded by leaking crude oil during the voyage from Bahrain to Cape Town. However, by the time the Cape Town samples were taken only three weeks later, there was no sign of continuing contamination by degradation of the flashpoint. Instead, the flashpoint was substantially restored to that of the shore tanks prior to loading on board the *Kodiak* suggesting there was no running leakage of crude into the fuel oil after ullaging and sampling at Bahrain and that the apparent increase in fuel oil volume was probably due to measurement error. I noted the contention of the plaintiffs that by the time the *Norseman* left Bahrain "the crew had learnt of the complaint and it may well be that some remedial measure was taken, which prevented any leakage from continuing" after the time of departure from Bahrain. As was pointed out by the defendants this could not have been the case because the plaintiffs heard of the contamination about a week after the *Norseman* sailed from Bahrain and its Master was informed on or about 23/24 February which was 8 or 9 days before Caleb Brett took the samples at Cape Town on 4 March.

Smaridge and Andreou were not agreed as to the amount of crude oil which would have to be introduced into the fuel oil cargo to reduce the flashpoint to 100 degrees Fahrenheit. Smaridge said 0.5%, that is, about 360 LT or 2,674 barrels, Andreou between 1115 LT and 1138 LT or 8,348 to 8,520 barrels. As was pointed out if one took Smaridge's 2,674 barrels (360 LT) as sufficient and assumed that such quantity of crude oil had already entered the *Norseman's* centre tanks before sampling and ullaging of fuel oil at Bahrain, the total quantity of cargo in the nos. 1, 2, 4 and 5 centre tanks after transhipment would be everything that was, transhipped plus 2,674 barrels. Yet if one compared the *Norseman* post-transhipment fuel oil received figure of 71,739.85 LT (P10/11A) with the *Kodiak* pre-transhipment figure, less the amount of crude oil remaining on board the *Kodiak* (114 LT), of 71,970 (P10/12A) one would find that there was a reasonably close correspondence. If one assumed that there was a further 360 LT already in the *Norseman's* tanks or introduced before ullaging, so that the true amount received by that vessel from transhipment was only 71,739 less 360 (71,379), there was an inexplicable discrepancy between the *Kodiak's* figures for what was discharged and the *Norseman's* figures for what was discharged and the *Norseman's* figures for what was received. In the opinion of both Waite and Pockett an amount as great as 360 LT would be noticeable over and above measurement error. In other words the 360 LT hypothetically in the *Norseman's* tanks would have shown up in a larger received figure registered on the *Norseman* at Bahrain. This suggest that the extra Crude oil was not present in the *Norseman's* centre tanks. If that were so, the reduced flashpoint recorded from the Bahrain samples was in consequence of contaminant already in the fuel oil on the *Kodiak* manifesting itself in unrepresentative samples taken at Bahrain as mentioned.

But, the defendants pointed out there was a more obvious objection to the argument that the flashpoint was reduced on the *Norseman* by the admixture of part of the *Norseman's* crude oil cargo. If there had been contamination of the fuel oil by crude from the *Norseman* before the Bahrain ullages were taken and further had there been subsequent admixture of crude also from the *Norseman's* cargo, there would have been a significantly large crude shortage than appeared to be the case. The apparent net reduction in crude oil on the *Norseman* was only 3087 barrels (P/16) whereas the apparent increase in fuel oil after the Bahrain ullages were taken was 3839 barrels (P/16). Thus according to Pockett the apparent crude shortage was not even enough to supply the apparent increase in the contents of the fuel oil tanks, let alone to supply enough crude, in addition, to reducing the flashpoint of the fuel oil substantially below the true level at the time of transhipment. Waite was unable to explain how, by reference to the quantities apparently involved, the crude losses and fuel oil gains could lead to the inference that crude oil had entered the fuel oil. I agreed that merely to point to apparent gains in fuel oil and apparent losses in crude was not enough to give rise to that inference having regard to the fact that the whole of the apparent fuel oil gain by definition must take place after any contamination recorded in Bahrain had already occurred.

It was contended by the plaintiffs that the evidence furnished by the defence as to the management and control of the *Norseman* was unsatisfactory. However, in my view, the primary evidence of the management and control of the *Norseman* and its cargo suggested that the chances of leakage from lines or valves could be dismissed as extremely improbable. As was pointed out, as recently as 13 January 1981 - a month before she loaded fuel oil at Bahrain - the *Norseman* had been subjected to her periodical survey on hull (see D/23) which had included thorough and comprehensive tank inspections by the surveyors from her classification society *Det Norske Veritas* leading to the conclusion, according to Pockett,

that her valves and lines were also pressure-tested for this purpose. Further according to the evidence of Gjernes, the vessel's tanks had been washed prior to arrival at Khor-al-Fakkan and her lines had been flushed. Thereafter Gjernes, in the presence of the Master entered and inspected the No. 5 centre and the No. 5 wing tank and found them clean. Then the classification society surveyors and Granheim inspected all the tanks.

Further, when the vessel arrived at Ju'Aymah for loading the Arabian Light crude, the tanks to be loaded were inspected by the cargo surveyors, Watson Gray (Saudi Arabia) Ltd. and found to be free of residues and slops as evidenced by P2/B6 which showed that the slops derived from the washings of the cargo tanks were segregated in the No. 6 port and starboard wing tanks and, according to Gjernes' evidence, were there kept segregated by at least two-valve separation. He also stated that the Arabian Light crude loaded at Ju'Aymah did not leak into any of the empty cargo tanks prior to loading at Mubarek which suggested that there was nothing wrong with the relevant valves at that time. His evidence also indicated that when the vessel arrived at Mubarek, all her empty cargo tanks were inspected and found in good condition free of slops which again showed that there was effective segregation of the Arabian Light and slops from the empty cargo tanks. The affidavit evidence of Granheim showed that after the loading of the Mubarek crude and up to the vessel's commencement of loading the fuel oil at Bahrain the empty centre tanks were regularly checked to see that they remained dry as he did this by taking dips each day and by visual inspection from deck level, as well as taking ullages of the wing tank crude cargoes.

Having watched Gjernes on the stand, I had no reason to disbelieve his evidence as to the preparation of the centre tanks for reception of fuel oil while the vessel was off Bahrain. He was a highly experienced tanker deck-officer, familiar with the operation of valves of the *Norseman's* sister ship and gave the impression that he must have been careful about control of cargo movement and management of the cargo lines. He was in particular adamant that the vessel's lines had been flushed to get rid of the crude oil remaining after loading at Mubarek. He was cross-examined thoroughly on the basis that in his statement D2/83 he did not refer to flushing the lines before loading the fuel oil. I accepted his explanation for the omission that it was such a normal and automatic procedure for the lines to be flushed before the fuel oil cargo was loaded that he did not mention it.

The evidence of Gjernes also showed that the entry in the Engine Room Log for 27 January 1981 - referring to stern on deck at 0800 was consistent with the use of the cargo pump and the stripping pump to strip the small quantity (about 2 ft.) of water out of the centre tanks into the slop tanks following flushing the lines and that although the exercise of washing dirty lines, that had already been flushed, into clean cargo tanks might not be the best practice if one did not subsequently re-wash the tanks before loading fuel oil, very little crude was likely to have been deposited in the clean tanks due to the comparatively short time of about 30 minutes that the dirty washings spent in each tank. Pockett also suggested that with a further period of about 1 hour for stripping only a trace of crude might have been left as a film on the surfaces of the centre tanks. Pockett also stated that if the lines had been flushed into the centre tanks but the flushings left in the tanks contrary to what Gjernes said, this would have been detected at the time of the tank inspection by Saybolt and the Chief Officer prior to transhipment. According to Pockett, the evidence as to the quantity of slops in the slop tanks was consistent with the lines having been flushed.

Gjernes was also challenged as to his account of dipping the centre tanks to make sure that they were empty before the arrival at Bahrain and loading fuel oil. It was suggested that if, as was the case, the vessel was trimmed by the stern, it was futile to dip from the ullage

plugs due to the wedge effect of the vessel's trim. However, it became clear in the course of his re-examination and with reference to Plan D3/4 that dips had been taken from the thermometer apertures located at the extreme left end of the tanks. If crude had been left in the lines it would, according to Pockett, have drained into the centre tanks and that would have been detected by dipping prior to transhipment.

The defence evidence also satisfied me that it was most improbable that there was failure to maintain the segregation of the fuel oil during the exercise of transhipment. As stated by Gjernes, on 8 February 1981, immediately prior to loading, the centre tanks were dipped in the presence of Saybolt's surveyor and found to be dry and empty. It was also in the evidence of Ytterland that he and Gjernes also looked down into the tanks with a flashlight "to see whether there were any residues or water or clingage to the ladders". If there had at that stage been inadequate segregation of the crude cargo there would have been crude in the centre tanks which would have been detected. The essential point was that this inspection of the tanks must have taken place after the valves which would have to be opened for the purposes of loading the fuel oil had already been opened in readiness for the loading operation and when there would therefore already be no more than one valve segregation between the crude oil on board and the lines and tanks to be used for loading the fuel oil: it would only be if all such valves were already open that one could issue a dry certificate as stated by Pockett.

The *Norseman* appeared to Pockett to be well-run and managed when he boarded her at Aghii Theodori and Ytterland formed the impression that the *Norseman* personnel were "competent". According to Granheim and Gjernes, there were strict standing orders for maintaining segregation of cargoes which were followed by Granheim in the setting up of the lines and valves under the supervision of the Chief Officer in preparation for the transhipment. There was also evidence to show that Ytterland checked with the Chief Officer the line set-up and the valve system before transhipment to ensure that segregation was maintained and also checked that the slops were segregated throughout transhipment and that when Pockett first went on board at Aghii Theodori the segregation of the fuel oil was effectively maintained and there were no leaking valves.

I was therefore satisfied that the primary evidence strongly suggested that there was indeed effective segregation of the fuel oil throughout the period of its custody in the *Norseman*.

It was common ground that the location of valves on the *Norseman* was such that during the operation of loading the fuel oil there would necessarily be no more than one-valve segregation between the fuel oil being loaded and the crude cargoes already on board. The evidence was that if there were a lever system, of tell-tale on deck for the hydraulic valves (which was the case) Gjernes should have known at any time exactly which valves were open or closed. It was therefore reasonable to conclude that the chances of the lines on the *Norseman* having been incorrectly set up at Bahrain were so small as to be virtually non-existent. It was also for this reason that I thought it inherently improbable that, having gone to the trouble of setting up the lines and valves in preparation for transhipment, as stated by Ytterland, Gjernes would have failed to observe if the correct set-up of the valves were not maintained throughout transhipment. Gjernes' evidence was that, upon completion of loading the fuel oil, he personally checked that all the valves which had been used for loading were closed. It was reasonable to assume that Gjernes would not have failed to notice that one or more of them had been left open. I was also impelled to the view that the chance of a gate valve, manually operated, being left open by mistake due to some obstruction preventing complete closure was highly unlikely.

It was also shown that the one-valve segregation would only occur during transhipment. Before the setting up of the lines for this purpose and after completion of transhipment the fuel oil ought to have been segregated by numerous valves from the crude oil. Both Waite and Pockett agreed that where there was more than one valve segregating the fuel oil from the crude oil there was very little chance that there could be undiscovered leakage due to a series of valves being left open accidentally or a series of valves all developing leakage due to defects. In the course of his cross-examination Waite was asked to consider the location of valves and the prospects of leakage of the crude into each one of the fuel oil tanks which showed an apparent gain in cargo during the course of the voyage otherwise than in the course of transhipment. The gist of his evidence was that:

(i) The likelihood of accidental leakage of Arabian Light crude into the fuel oil tanks must be very slight because there was between 3- and 9-valve segregation between the crude and fuel oil except in two cases where there was 2-valve segregation, namely No. 3 wing to No. 4 centre and No. 5 wing to No. 4 centre. However, because No. 4 centre apparently sustained a loss in volume during the voyage it could be ignored and 3 wing tanks were not shown by the ullages to have lost any crude although he did not accept that they had gained any.

(ii) Between No. 5 wing tanks (Arabian Light crude, apparent loser) and No. 1 centre (fuel oil, apparent gainer) there was 5-valve segregation. Between No. 5 wing tanks and No. 2 centre (fuel oil, apparent gainer) there was 3-valve segregation.

(iii) It was difficult to envisage the accidental intertank transfer or leakage from No. 5 wing tanks across the multiple valve segregation to No. 1, 2 or 4 centre tanks.

(iv) It was highly unlikely that the Mubarek crude could have been transferred accidentally or by leakage through defective valves into the fuel oil tanks because:

(a) No. 2 wing tanks had 4-valve segregation from No. 1 centre (an apparent fuel oil gainer);

(b) No. 2 wing tanks had 7-valve segregation from No. 2 centre (an apparent fuel oil gainer);

(c) No. 4 wing tanks had 2-valve segregation from No. 1 centre;

(d) No. 4 wing tanks had 5-valve segregation from No. 2 centre.

Thus it appeared the only alternative means by which crude could have entered the fuel oil after ullaging at Bahrain would be if it were deliberately mixed with the fuel oil and this, I agreed with the defendants, would have been such a stupid course of action that it could be dismissed out of hand. It was Pockett's evidence that there was no logical explanation on the available evidence for the apparent overall increase in the volume of fuel oil on board the *Norseman*. However, on the evidence he had seen, he considered that there had been no true increase and the "increase" was due to measurement error. In so far as there appeared to have been losses and gains between the fuel oil tanks, these could have been due to deliberate alterations of trim of the *Norseman* associated with taking on extra bunkers.

From the above evidence, I agreed with the defendants, that it could not be inferred that it was more probable than not that during the *Norseman's* custody of the fuel oil further contamination by crude oil took place or that its effect was to reduce the flashpoint from on or above specification to below specification. There was nothing to establish that any material part of the cargo was at or above specification when it entered the *Norseman* and nothing

to establish that once it entered the *Norseman* it was further contaminated and, if so, to what extent and in particular whether any material part was degraded below specification due to its reduced flashpoint.

The Chemists' Evidence

It was shown that the chemical evidence originated in the investigations conducted by Andreou in May 1981, commencing with instructions from Pockett on behalf of the Owners' P & I Club. There was at that time two distinct areas of investigation. The first was directed to the analysis of a total of 10 samples of fuel oil taken at Bahrain (No. 6), Cape Town (No. 2, 3, 4 and 5), Sines (No. 1), Aghii Theodori (No. 7, 8, 9 and 10), in order to ascertain mainly the flashpoint, viscosity and specific gravity. The second area of investigation was to ascertain whether the fuel oil had been contaminated by diesel or the crude oil on board the *Norseman*. For this purpose Andreou obtained from the Motor Oil Refinery Laboratory in Greece, the remains of the samples of the Arabian Light crude and Mubarek crude (samples No. 11 and 12 respectively) which had been carried on the *Norseman* and discharged at Aghii Theodori.

Andreou duly prepared a report dated 18 May 1981 (P2/G/19) in which he recorded the analysis results of the 12 samples. In relation to the second area of his investigations as to whether diesel or crude from the *Norseman* had contaminated the cargo, Andreou prepared two further reports of 25 and 28 May 1981 (P2/G/25 and P2/G/13 respectively) with the material conclusions set out on P2/G/27 and P2/G/17-18. Infrared spectroscopy ("IR") played an important part. As shown:

(i) At P2/G/27
- (a) Sample No. 6 of fuel oil taken by Saybolt at Bahrain was found to have some peaks which were the same as the characteristic peaks of sample No. 11 Arabian Light crude.
- (b) The most linear diagram was that derived by comprising a 1% dilution of Arabian Light crude in fuel oil from the Aghii Theodori samples in benzene with a dilution of sample No. 6 in benzene.

(ii) At G/17-18
1. Sample No. 6 (the Bahrain after transhipment sample) had been contaminated by crude oil.
2. That sample was not really representative of the fuel oil cargo.
3. The contaminant was not Mubarek crude.
4. The presence of Arabian Light crude in the proportion of less than 1% was ascertained.
5. The contaminant was a crude oil different from Arabian Light crude and/or Mubarek crude which in Andreou's opinion was:
   - (a) a medium crude; and
   - (b) at a percentage of about 5%.

Apart from IR work carried out in May 1981 to confirm conclusion 5 above and not the subject of a separate report to his clients Andreou received no further instructions and did no further work on the case until the end of 1987 when he was instructed to prepare for the trial of this action. In the meantime, he had destroyed his working papers including the print-outs of the IR spectra in accordance with his usual practice of doing so after five years. Consequently all his evidence of the original IR work had to be based on his recollection of the appearance and his interpretation of the IR spectra in 1981.

The original chemical evidence referred to above was supplemented by further reports prepared in the course of 1988 for the purposes of the trial. The original reports depended on both chemical analysis and IR. The later reports depended only on chemical analysis and not an IR.

The Evidence based on IR

The substance of Andreou's evidence was as follows:

(a) He used equipment SP 1050 Pye Unicam which enabled him to obtain enlarged spectra on very large print-outs by means of the "low noise" setting and accentuated spectra by the transmittance scale expansion device.

(b) This equipment also enabled him by means of the differential facility to obtain a printout derived from comparing one substance in the sample cell with another substance in the reference cell, so that if the two substances were identical in all material respects they would give a straight line or "linear" print-out. The more the substances diverged in relevant constituents the less linear the print-out would be.

(c) In order to conduct the IR analysis he used a benzene solution, allowing the heavier constituents of the crude oil samples to "self-setde", that is, precipitate, leaving the lighter and more volatile liquids in solution and concentrating on the IR spectra derived from that solution, the heavier constituents and the gases contained in crude being irrelevant to the IR analysis.

(d) The comparative IR exercise adopted by Andreou involved firstly placing one printout over another on top of a lighted glass in order to identify the extent to which the morphology of the upper part of the peaks differed and secondly the use of the differential facility on his equipment to see how linear the IR comparison was, while getting rid of negative peaks from the benzene by use of the transmittance scale expansion device.

(e) Before embarking on his IR experiments in 1981 Andreou was aware of and had in mind the obvious disparity apparent from the chemical analyses of the various samples between:

(i) a flashpoint reduced to no lower than 111 degrees Fahrenheit which was well above ambient temperature;

(ii) a viscosity reduced from over 2000 seconds to as low as 870 seconds;

(iii) a specific gravity reduced down as far as 0.9516 gm. in sample No. 6 by comparison with much higher specific gravities found in samples taken at Cape Town, Sines and Aghii Theodori.

The substance of the disparity which struck him was that it needed a relatively high proportion of neat crude oil to reduce the viscosity and a very much smaller quantity to reduce the flashpoint only to 111 degrees Fahrenheit, as distinct from ambient temperature or below.

(f) When he carried out the comparative IR experiment he found that some but not all of the relevant upper peak morphology of Arabian Light crude (Sample 11) was the same as the relevant upper peak morphology of sample No. 6, the contaminated fuel oil. This enabled him to conclude that sample No. 6 contained a substance which was "something like" Arabian Light crude but not exactly Arabian Light crude. If it had been exactly Arabian Light crude there would not have been such differences in the peaks as he

found by comparing the spectra. This was "step (a)". He also found in "step (b)" that he obtained by the differential device on his equipment the most linear print-out when he compared sample No. 6 with a 1% dilution of Arabian Light crude in fuel oil taken from the Aghii Theodori samples. He was therefore able to conclude that there was present in sample No. 6 a substance similar to but not identical with Arabian Light crude in the proportion 1%.

(g) Mubarek crude was found by IR not to be present in sample No. 6 because sample No. 12 had no relevant peaks which were the same as sample No. 6.

(h) The conclusion, para. 5 at P2/G/18, was not arrived at by IR technique but was Andreou's estimate and opinion derived from his experience of fuel oil and medium crude and from the disparate chemical analysis results described at (e) above. He subsequently conducted an IR investigation for his own curiosity which was not the subject of or mentioned in any report to his clients. This involved creating a blend of Libyan crude, Mubarek crude and Arabian Light crude in equal parts, but having first extracted the more volatile liquids from the Mubarek crude and Arabian Light crude then introducing the blend into fuel oil taken from the *Norseman* at Aghii Theodori and then comparing that dilution with sample No. 6 on his IR equipment. He found a linear diagram very close to that of sample No. 6 with a dilution of 5% medium blend in fuel oil. Based on these proportions he was of the view that the flashpoint, viscosity and specific gravity could be reduced by roughly the right amounts if there was contamination of sample No. 6 by 5% of a substance very similar to his medium crude blend.

The significance of the IR evidence, as pointed out by the defendants, was that:

(a) it supported the other indirect evidence which strongly supported the view that sample No. 6 did not contain either Arabian Light crude or Mubarek crude which came from the cargo already on board the *Norseman*; and

(b) it supported the other indirect evidence which supported the view that a low flashpoint contaminant having similar characteristics to medium crude got into the fuel oil at some stage before transhipment.

The IR evidence was challenged on a number of bases but it was my view that on none of these bases had the plaintiffs actually invalidated Andreou's basic conclusions.

Smaridge had suggested that one could not use IR techniques to distinguish crude oil from fuel oil and that IR certainly could not be used to identify small proportions of crude oil in fuel oil. I agreed with the defendants that this evidence carried little weight having regard to the fact that Smaridge had never had experience of using equipment with such facilities as that used by Andreou, namely the SP 1050 Unicam with low noise setting and transmittance scale expansion. The equipment SP1000 with which Smaridge was familiar was incapable of providing large scale expanded print-outs and lacked the more sophisticated differential facility of the SP1050. It was shown to me that Andreou by contrast had significant experience of using his equipment for investigating slops by comparison with crude oil and contaminants in fuel oil.

It was suggested that the use of benzene would in itself throw up spectra which would make impossible any meaningful comparison between different substances diluted in benzene. I accepted Andreou's evidence that this technique was effective for comparative purposes because the only relevant constituents of the substances required to be compared were the light liquids which were soluble in benzene and that the transmittance scale expansion device could be used to get rid of any negative peaks attributable to the constituents of benzene.

It was further suggested that the comparative exercise could not be effectively carried out due to variation in concentration of the samples under investigation giving spectra which suggested that different substances were present. Andreou did not accept that this would invalidate the technique provided that one kept the same wave-lengths and parameters on the equipment as well as the same cell thickness and that the dilutions of the samples under comparison were the same and that the time allowed for self-setting was the same.

It was suggested that the result of the comparative experiment using the medium crude blend was misconceived because it proved no more than that the sample No. 6 contained contaminant constituted by equal parts of Arabian Light, Mubarek and Libyan crude. Andreou pointed out that this overlooked the essential fact that the blend contained no neat Arabian Light crude or, Mubarek crude, the very light liquids having already been extracted before blending in order to avoid an excessively low flashpoint and viscosity.

It was further suggested that by the time Andreou came to conduct his analysis in May 1981 the crude oil sample, that is sample No. 11 and sample No. 12, being only drawn from remnant samples at Motor Oil, might have lost their lighter components and therefore not have been representative of the crude oil in its condition while on board the *Norseman* and therefore unsatisfactory for purposes of comparison with the contents of sample No. 6. Similarly it was suggested that sample No. 6 itself, not being sealed, might have lost its lighter components and therefore might not accurately represent the condition of the *Norseman's* cargo as it was after transhipment. Andreou's evidence in relation to the Mubarek and Arabian Light crude samples was that they would probably have lost their gases and a small part of C5, the lightest non-gaseous constituent of crude oil. I accepted his evidence that the laboratory standards of Motor Oil, which was "the biggest refinery in the whole Mediterranean area", were strict and were such that the samples would have been kept in properly closed containers. As for sample No. 6, Andreou could not remember the precise condition of the cap but he thought it was "rather well closed" as he would have noticed if the cap had been loose. He stated that whereas the gases would have escaped, the volatile liquids would not substantially escape. I was invited by the defendants to accept that the close correspondence of the flashpoint results obtained by Core in their analysis of the other after-transhipment sample with the results obtained by Andreou in sampling sample No. 6 strongly suggested that sample No. 6 had been adequately closed and that because the crucial components for the purpose of IR comparative work were the light liquids, the escape of gases was irrelevant. I had no reason not to do so.

Having regard to Andreou's practical experience in this field of expertise I did not think that I ought to have been sceptical as to the value derived from his IR experiments. The defendants' case was that the contaminant did contain some lighter liquids and it was these that caused the flashpoint to be downgraded and that the contaminant in sample No. 6 was like a crude which had lost some of its flashpoint reducing constituents. As a result of the IR evidence, I agreed with the defendants that most if not all the contaminant in sample No. 6 was not crude from the *Norseman's* cargo because the proportion of lighter material in the sample which gave such a considerably reduced specific gravity compared with that of the Bahrain shore tanks was so substantial (it would have had to consist of 17% neat Arabian Light crude as shown by the tonnages at D/9/15, para. 4) that the flashpoint and viscosity, of the Bahrain sample should have been far below that found by Core or by Andreou and that whatever was in sample No. 6 it was therefore mostly not neat crude but must have been a weathered contaminant which could only have come from the *Kodiak*.

The Later Chemical Evidence

The reports of Andreou at D9/2 and D/l5 Section A, dealt with how much Arabian Light crude would have to be introduced into the fuel oil to reduce the flashpoint and viscosity to that of sample No. 6. It was accepted that the use of fuel oil having an initial flashpoint of 130 degrees Centigrade (the *Banoco Kodiak* sample showed 120 Degrees Centigrade) gave a more accurate result than the fuel oil of flashpoint 196 Degrees Centigrade initially used at D/9/3. It would have taken about 2 percent Arabian Light crude to reduce the flashpoint to 44 Degrees Centigrade (that of sample No. 6) but to achieve a viscosity of 870 seconds it would have been necessary to have about 8% Arabian Light crude in the mixture.

I accepted Andreou's explanation that that proportion of Arabian Light crude would have reduced the flashpoint to well below ambient temperature but would have been wholly insufficient to reduce the specific gravity to 0.9516 gm. (11-17 percent). This result was further evidence that the contaminant could not have been crude from the *Norseman's* cargo. Smaridge's counter experiments (P/23 and P/24) were shown by Andreou to have no evidential significance having been carried out with cracked fuel oil from which the more volatile liquids had already been extracted and not, as had Andreou's experiment, with straight-run fuel oil like the *Norseman's* cargo.

Andreou calculated at D/l5/11-12 the quantities of Arabian Light crude which, on the basis of his experiments at D/15 Section A, would have had to be introduced into the fuel oil on the *Norseman* to produce an overall flashpoint reduction to that of sample No. 6 (111 degrees Fahrenheit). The result (D/15/12) would be 1,274 to 1,300 tons depending upon the specific gravity of the fuel oil. This was far in excess of any loss of crude thrown up by the ullage variations between Bahrain and Aghii Theodori. As was explained by the defendants if such a quantity of crude had been lost there would have inevitably been a claim for short delivery by the receivers of the crude at Aghii Theodori.

Andreou's reconditioning experiments, I was satisfied, established that, whatever the condition of sample No. 6, the cargo as a whole could not have had a flashpoint as low as 111 degrees Fahrenheit (44 Degrees Centigrade) when the vessel left Bahrain. The experiments were conducted with a mixture of gasolene in fuel oil but because, as was stated, what matters is the evaporation of the lighter liquids in crude oil which are those present in gasolene, the results were valid as giving a view of the amount of time which would be required to recondition the whole cargo. It was shown to my satisfaction that Andreou's experiment was conducted in conditions which were much more favourable to reconditioning than those experienced on the *Norseman*. For one thing, the mixture was heated, whereas prior to Cape Town the cargo was not so that if the overall flashpoint of the cargo after transhipment at Bahrain was 44 degrees Centigrade it would have taken 50 days to raise the flashpoint to 20 degrees Centigrade with heat. It actually appeared to from 44 degrees centigrade to 104 degrees Centigrade (that is 60 degrees Centigrade) in the course of the 25 days' voyage to Cape Town without heat. I accepted the inference that the flashpoint of the whole cargo could not have been anywhere near as low as 44 degrees Centigrade. Andreou considered that Smaridge's counter-experiment was unsatisfactory because it was based on cracked fuel oil and because there was a lack of continuous stirring to stimulate sea conditions.

It appeared to me that Andreou's experiments generally supported his conclusions that:

(i) the contaminant in sample No. 6 was not neat crude, that is having lost its volatile liquids, its flashpoint and viscosity being substantially higher than that of neat crude.

(ii) Sample No. 6 was not a truly representative sample of the whole cargo which could not possibly have contained the percentages of crude oil required to reduce the specific gravity to 0.9516 gm.

(iii) a truly representative sample would have had a substantially higher flashpoint, viscosity and specific gravity.

In the light of the foregoing, I was of the view that the plaintiffs fell short of proving that any significant part of the fuel oil was contaminated on the *Norseman* to the extent that it was below specification or that if a significant part was contaminated to that extent such contamination only occurred after transhipment into the *Norseman.*

Also found at [1992] 4 CLJ 2255